WHAT IS CLAIMED IS:

1. A method of promoting the rate of hematopoietic cell multiplication, comprising administering an effective amount of a CXCR4 antagonist to hematopoietic cells.

2. The method of claim 1, wherein the hematopoietic cells are hematopoietic stem or progenitor cells.

3. A method of increasing the circulation of hematopoietic cells in a patient in need of such treatment, comprising administering to the patient an effective amount of a CXCR4 antagonist to mobilize the hematopoietic cells from a marrow locus to a peripheral blood locus.

4. The method of claim 1, further comprising introducing a heterologous gene into the hematopoietic cells for gene therapy.

5. The method of claim 1, wherein the hematopoietic cells are *ex vivo*.

6. The method of claim 1, wherein the hematopoietic cells are *in vivo*.

7. The method of claim 1, wherein the hematopoietic cells are selected from the group consisting of hematopoietic stem cells and hematopoietic progenitor cells (including CFU-GEMM, BFU-E, CFU-Meg, CFU-GM, CFU-M/DC CFU-$E_O$, CFU-Bas, Pro-B cells and lymphoid stem cells), that are known to differentiate into mature myeloid and lympoid blood cells, including erythrocytes, platelets, neutrophils, monocytes, macrophages, dendritic cells (myeloid and lymphoid related), eosinophils, basophils, mast cells, B cells. and T cells.

8. The method of claim 1, wherein the CXCR4 antagonist comprises a CXCR4 antagonist peptide.

9. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSLSYRCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ VCIDPKLKWIQEYLEKALN (SEQ ID No. 1);

KGVS**P**SYRCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ VCIDPKLKWIQEYLEKALN (SEQ ID No. 2);

KGVSL**P**YRCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ VCIDPKLKWIQEYLEKALN (SEQ ID No. 3);

KGVSLS**P**RCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ VCIDPKLKWIQEYLEKALN (SEQ ID No. 4);

KGVSLSY**P**CPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ VCIDPKLKWIQEYLEKALN (SEQ ID No. 5);

KGVS**P***SYRCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR QVCIDPKLKWIQEYLEKALN (SEQ ID No. 6);

KGVSL**P***YRCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR QVCIDPKLKWIQEYLEKALN (SEQ ID No. 7);

KGVSLS**P***RCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR QVCIDPKLKWIQEYLEKALN (SEQ ID No. 8);

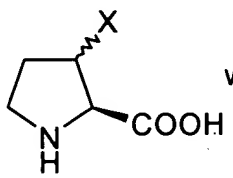
KGVSLSY**P***CPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR QVCIDPKLKWIQEYLEKALN (SEQ ID No. 9);

KGVS**Btd**YRCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR QVCIDPKLKWIQEYLEKALN (SEQ ID No. 10);

KGVSL**Btd**RCPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR QVCIDPKLKWIQEYLEKALN (SEQ ID No. 11);

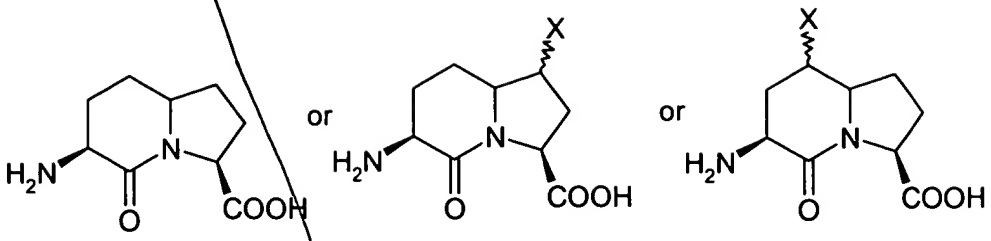
KGVSLS**Btd**CPCRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR QVCIDPKLKWIQEYLEKALN (SEQ ID No. 12);

wherein P* =




with X= Ar, Ar-OH, alkyl and more

and Btd =




X= Alkyl, Ar, Ar-OH and more

sub Q12

10. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

a) KGVSLSYRCPCRFFESH

b) KGVSLSYRC

11. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

| | |
|---|---|
| KGVS**P**SYRCPCRFFESH | (SEQ ID No. 17) |
| KGVSL**P**YRCPCRFFESH | (SEQ ID No. 18) |
| KGVSLS**P**RCPCRFFESH | (SEQ ID No. 19) |
| KGVSLSY**P**CPCRFFESH | (SEQ ID No. 20) |
| KGVS**P***SYRCPCRFFESH | (SEQ ID No. 21) |
| KGVSL**P***YRCPCRFFESH | (SEQ ID No. 22) |
| KGVSLS**P***RCPCRFFESH | (SEQ ID No. 23) |
| KGVSLSY**P***CPCRFFESH | (SEQ ID No. 24) |
| KGVS**Btd**YRCPCRFFESH | (SEQ ID No. 25) |
| KGVSL**Btd**RCPCRFFESH | (SEQ ID No. 26) |
| KGVSLSBtdCPCRFFESH | (SEQ ID No. 27) |
| KGVS**P**SYRC | (SEQ ID No. 28) |
| KGVSL**P**YRC | (SEQ ID No. 29) |
| KGVSLS**P**RC | (SEQ ID No. 30) |
| KGVSLSY**P**C | (SEQ ID No. 31) |
| KGVS**P***SYRC | (SEQ ID No. 32) |
| KGVSL**P***YRC | (SEQ ID No. 33) |

KGVSLS**P***RC (SEQ ID No. 34)

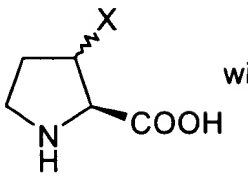
KGVSLSY**P***C (SEQ ID No. 35)

KGVS**Btd**YRC (SEQ ID No. 36)

KGVSL**Btd**RC (SEQ ID No. 37)

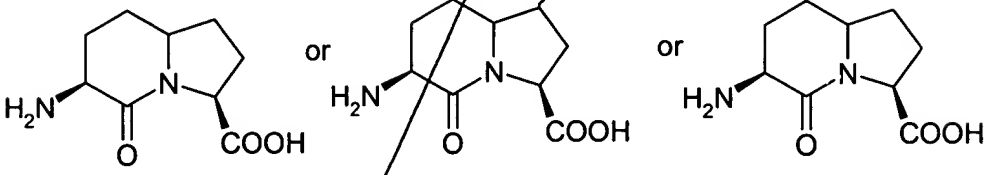
KGVSLS**Btd**C (SEQ ID No. 38)

wherein P* =



with X= Ar, Ar-OH, alkyl and more

and Btd =



X= Alkyl, Ar, Ar-OH and more

12. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVS**P**SYRC KGVSL**P**YRC KGVSLS**P**RC KGVSLSY**P**C

KGVS**P**SYRC KGVSL**P**YRC KGVSLS**P**RC KGVSLSY**P**C

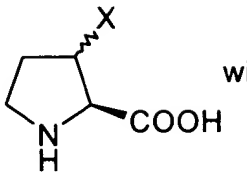
KGVS**P***SYRC KGVSL**P***YRC KGVSLS**P***RC KGVSLSY**P***C

KGVS**P***SYRC KGVSL**P***YRC KGVSLS**P***RC KGVSLSY**P***C

KGVS**Btd**YRC KGVSL**Btd**RC KGVSLS**Btd**C

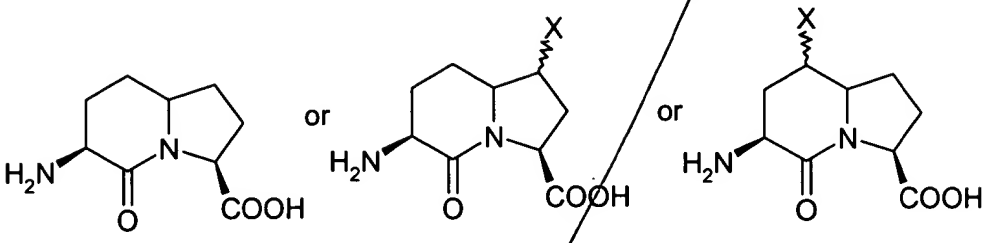
KGVS**Btd**YRC KGVSL**Btd**RC KGVSLS**Btd**C

wherein P* =



with X= Ar, Ar-OH, alkyl and more

and Btd =



X= Alkyl, Ar, Ar-OH and more

13. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSPSYR — X — KGVSPSYR

KGVSLPYR — X — KGVSLPYR

KGVSLSPR — X — KGVSLSPR

KGVSLSYP — X — KGVSLSYP

KGVSP*SYR — X — KGVSP*YR

KGVSLP*YR — X — KGVSLP*YR

KGVSLSP*R — X — KGVSLSP*R

KGVSLSYP* — X — KGVSLSYP*

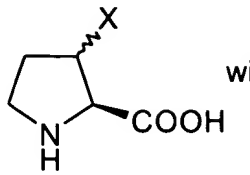
KGVSBtdYR — X — KGVSBtdYR

KGVSLBtdR — X — KGVSLBtdR

KGVSLSBtd — X — KGVSLSBtd

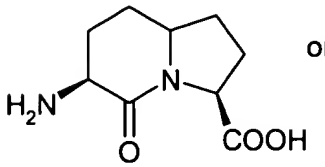
wherein X is a natural or unnatural amino acid linker between each of the arginines at position 8 in each sequencel; and,

wherein P* =



with X= Ar, Ar-OH, alkyl and more

and Btd =



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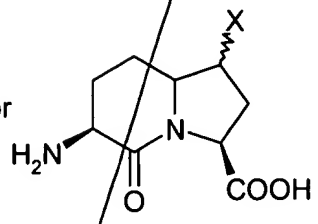

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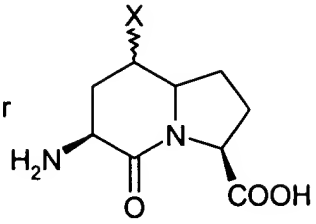


X= Alkyl, Ar, Ar-OH and more

14. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:
KGVSLSYRCPCRFF-$G_n$-LKWIQEYLEKALN (SEQ No. 63)
KGVSLSYRCPCRFFESH-$G_n$-LKWIQEYLEKALN (SEQ No. 64)

wherein n is an integer from 0 to 10.

15. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:
KGVSLSYRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN (SEQ No. 65)
KGVSLSYRCPCRFFESH-$(CH_2)_n$-LKWIQEYLEKALN (SEQ No. 66)

where n is an integer from 1 to 20.

16. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:
KGVS**P**SYRCPCRFF-GGGG-LKWIQEYLEKALN;
KGVSL**P**YRCPCRFF-GGGG-LKWIQEYLEKALN;

KGVSLSPRCPCRFF-GGGG-LKWIQEYLEKALN;
KGVSLSYPCPCRFF-GGGG-LKWIQEYLEKALN;
KGVSPSYRCPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSLPYRCPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSLSPRCPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSLSYPCPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSPSYRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLPYRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLSPRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLSYPCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSPSYRCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLPYRCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLSPRCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLSYPCPCRFFESH- $(CH_2)_n$ –LKWIQEYLEKALN,

wherein n is an integer from 1 to 20.

17. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSP*SYRCPCRFF-GGGG-LKWIQEYLEKALN;
KGVSLP*YRCPCRFF-GGGG-LKWIQEYLEKALN;
KGVSLSP*RCPCRFF-GGGG-LKWIQEYLEKALN;
KGVSLSYP*CPCRFF-GGGG-LKWIQEYLEKALN;
KGVSP*SYRCPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSLP*YRCPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSLSP*RCPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSLSYP*CPCRFFESH-GGGG-LKWIQEYLEKALN;
KGVSP*SYRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLP*YRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLSP*RCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLSYP*CPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSP*SYRCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;
KGVSLP*YRCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;

KGVSLSP*RCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;

KGVSLSYP*CPCRFFESH-$(CH_2)_n$ –LKWIQEYLEKALN;

KGVSBtdYRCPCRFF-GGGG-LKWIQEYLEKALN;

KGVSLBtdRCPCRFF-GGGG-LKWIQEYLEKALN;

KGVSLSBtdCPCRFF-GGGG-LKWIQEYLEKALN;

KGVSBtdYRCPCRFFESH-GGGG-LKWIQEYLEKALN;

KGVSLBtdRCPCRFFESH-GGGG-LKWIQEYLEKALN;

KGVSLSBtdCPCRFFESH-GGGG-LKWIQEYLEKALN;

KGVSBtdYRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;

KGVSLBtdRCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;

KGVSLSBtdCPCRFF-$(CH_2)_n$–LKWIQEYLEKALN;

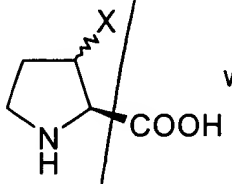
KGVSBtdYRCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;

KGVSLBtdRCPCRFFESH-$(CH_2)_n$–LKWIQEYLEKALN;

KGVSLSBtdCPCRFFESH- $(CH_2)_n$ –LKWIQEYLEKALN,

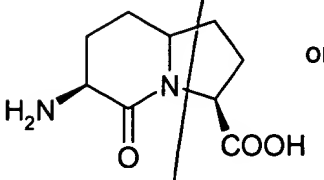
wherein n is an integer from 0 to 20 and

wherein P* =



with X= Ar, Ar-OH, alkyl and more

and Btd =



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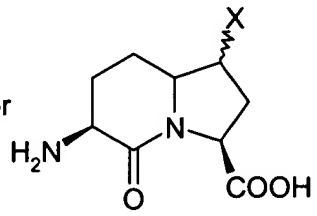

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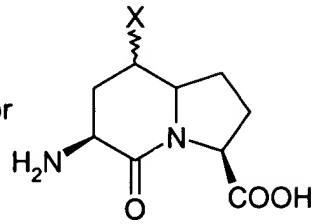

X= Alkyl, Ar, Ar-OH and more

18. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN

KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN

KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN

KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN

19. A CXCR4 antagonist peptide selected from the group consisting of:

KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN

KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN

KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN

KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN

20. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSLSYRCPCRFFGGGGSKPGVIFLTKRSRQV;

KGVSLSYRCPCRFF$(CH_2)_n$ SKPGVIFLTKRSRQV;

KGVSLSYRCPCRFFGGGGEEWVQKYVDDLELSA;

KGVSLSYRCPCRFF$(CH_2)_n$ EEWVQKYVDDLELSA,

where n is 0 or an integer between 1 and 20.

21. A method of treating a cancer in a patient in need of such treatment comprising administering an effective amount of a CXCR4 antagonist to the patient to promote the rate of hematopoietic cell multiplication.

22. A method of treating an autoimmune disease in a patient in need of such treatment comprising administering an effective amount of a CXCR4 antagonist to the patient to promote the rate of hematopoietic cell multiplication.